Experimental Investigation On Effects Of Wear Behaviour On Natural Hybrid Composites

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Abstract

Lack of resources and increasing environmental pollution has evoked great interest in the research of materials that are friendly to our environment. In the present research, Cork/Egg shell and Cork/Egg shell/Fly ash Natural hybrid composites are manufactured by varying weight percentages 60:40,70:30,80:20,90:10, 60:20:20,60:15:15,80:10:10,90:5:5 having particle has 50microns by using hand lay method. Hardness test and advanced computerized wear test was performed for wear evaluation with EN32 steel disk and round pin for the natural composite material samples.

The influence of Cork+ egg shell and cork+ eggshell + flyash composites on the hardness, weight loss, Wear resistance and coefficient of friction is determined for the natural composites. The consequence of the tribological test on Morphology of composites was analysed using SEM. The results show that composites reinforced with natural composites have an improvement in tribological properties due to their positive economic and environmental aspects, hybrid natural composites are showing a good potential for employing in Brake pads and Friction lining materials.

1. Introduction

In the last two decades, research was Carried out on the natural fiber reinforcement composites. So, the natural wastage of cork, egg shell and fly ash are available quite a lot and at this time has not been utilised properly. At the present days, the natural composites as raw material is a fairly trend to future applications, in order to improve mechanical properties. In automobile field, different component have dissimilar properties based on their usage but to good performance must have low weight, high strength, high wear resistance, low wear rate and coefficient of friction [1]. Omrani,Eet al. [2]make an effect to examine hardness test by brinell hardness, which evaluate the mechanical properties of cork specimens. The specimen presented large deformations are relatively low stresses, consistence with the low value of the material of modulus elasticity. The material elastic zone was relatively small (low value of yield stresses), but well defined. Singha, Amaret al. [3]torevealed the friction material used for cork and/or copper powder metal. The application applied to clutch friction lining material like inner disk is steel and outer disk is bronze. While low for stress as well as strain but temperature distribution, heat flux values for copper metal is moderate than cork material usage of copper powder as surface lining is better than using cork.Thakuret

al. stated the heat treatment temperature of egg shell particles was inversely to the yield of obtained adsorbent. Increase in temperature causes the decrease of water content in the egg shell particles resulting the decrease of the yield[4]. Vigneshkumar et al. [5] to find out the possibilities of using egg shell waste and waste paper to produce recycled paper, where to get maximum tensile strength. Norihan et.al, [6]to investigate the mechanical properties and water absorption of egg shell polymer composite as a function of egg shell to combines with calcium carbonate polymer composite with (15, 20)weight % to obtain desired properties such as increase with increase egg shell powder content and decrease in filler particles as well as decreased in particle size. SharmeeniMuruganet al. [7]to investigate of egg shell to the recycled aluminium can has enhanced the modulus of elasticity which in turn increases the rigidity of the produced composites. Addition of egg shell particle increase with increase of weight percentage of increasedof yield stress and tensile strength. The enhanced wear resistance and hardness of the aluminium and egg shell composites over the aluminium can cast mould to high strength and hardness of the egg shell particles.Achala Amarasinghe1 et.al.,[8]to evaluate the usage of egg shell and microsilica is added in various ratio for cement replacements. Egg shell powder (5%) and microsilica (20%)can be added without any reduction in compressive strength properties of convectional cement while (5%) of egg shell and microsilica (10%) replacement in cement yield higher split strength as compared to other composites.Ch.Netravali et. al. [9]to combined on fly ash used as a different wt % such as 5%, 10%, 15%, 20% and 25% by dispersing it into al/fly ash to produce composite by stir casting method. Increase the content of fly ash, the toughness value is increased as well as increase hardness and tensile strength. Addition of ash content in order to decreased the density of the composite. Hence the light weight of an object likes aero and space industries. Ruben Y. Baltoet al. [10]by combination of glass-epoxy composite and fly ash (wt 6%) content was found greater BHN value compare to 3% and 9% of composite material.Faiza ben addallah et al. examined the polypropylene reinforced with cork (wt 5%)form a composite with increase young's modulus and stress at break. Adding concentration, no impact on tensile, flexural and compressive properties Gowsika Det.al.,[11]. Pliya, Pet al. has worked to improvement of interfacial bonding of thermoplastics with mixture of cork (wt 50%) to promote adhensive between the cork and polyolefin phase, to improve tensile strength and the cork dispersion [12]. In the present investigation Cork, Cork+Egg shell with different Wt.% ratios and Cork+Eggshell+Fly ash with different Wt.% ratios are manufactured by using hand lay method and hardness test is conducted for better hardness and Tribological tests such as wear rate, weight loss and Coefficient of friction are conducted to validate which composites are best suited as lining materials over the surface of friction plate.

2. Experimental Procedure

2.1 Material

Cork, egg shell and fly ash are collected from local resources areas. Ly556 resin epoxy and hy951 hardner were buyed from Chennai, india.

Fig. 1.a.Cork Powder b. Egg shell powder c. Fly ash powder

2.2 Processing

Various types of natural fiber reinforced composites are cork, egg shell and fly ash are available a lot. After the collection of raw material particles are grinded and sewing into 50 micron of size. To calculate the mass (g) of cork, egg shell and fly ash are based on density formula of 7g, 21g and 26g respectively. Based on weight percentage, the different percentage of composite are fabricated. The matrix used the unsaturated polymer resin. The composite are prepared as pvc pipe of cylindrical shaper as fixed dimensions. The length and diameter of pvc pipe has 65mm and 10mm respectively. The mixing ratio of resin and hardener is 9:1. The preparation of cork was mixed with resin and hardener to fused in mould pipe as required dimensions. Same step for composite of combined cork and egg shell with different composite ratio are 60:40, 70:30, 80:20 and 90:10 are prepared with required dimensions. Another same step for composite material are cork, egg shell and fly ash to mixed with different ratio are 60:20:20, 70:15:15, 80:10:10 and 90:5:5 respectively are prepared with required dimension.

These steps are followed to make three different composites. Forhybrid composite, the primary material is cork, with incorporated are egg shell and fly ash composites.The three different types of composites table 1.

Table1. Types of composite fabricated

Composite 1	Composite 2	Composite 3
Cork	Cork	Cork
	Egg shell	Egg shell
		Fly ash

The natural composite fibers are cork, egg shell and fly ash and polymer Matrix was analysed for wear with ASTM G99. Wear and friction monitor – TR 201, (pin on disc) wear apparatus specification shown in Table 2.

Table2. Tribological test specification

S.No	Discription	Properties
1.	Pin size	2mm - 10 mm
2.	Disc size	6mmX100mm
3.	Wear	2000micrometer
4.	Frictional force	100N

Wear testing machine setup with specimen.

b.

Fig. 2.a.Binder-LY 556, Hardner-HY95 b. Specimens c. Final Specimens after Machining

3. Result and Discussions

Table3. Hardness Test Results for specimens

S.No	Cork	Egg Shell	Fly Ash	Hardness
1	100	---		49
2	90	10		51
3	80	20		64.5
4	70	30		73
5	60	40		60
6	90	5	5	62
7	80	10	10	67
8	70	15	15	82
9	60	20	20	76

Wear rate, weight lossand coefficient of friction and wear rate done using L9 orthogonal array.

Fig. 3. Wear test Experimental Setup.

Table4. Tribological Test Results for specimens

S.No	Specimen	Cork	EggShell	Fly Ash	Wear Rate- mm^{3}/min	Weight Loss- grams	COF- μ
1	S1	100	-	-	0.013613	0.8576	0.0195
2	S2	90	10	-	0.0041887	0.6575	0.0231
3	S3	80	20	-	0.000401	0.575	0.0389
4	S4	70	30	-	0.0003371	0.5437	0.0567
5	S5	60	40	-	0.00004977	0.384	0.0671

6	S6	90	5	5	0.0026179	0.375	0.0206
7	S7	80	10	10	0.0001738	0.1512	0.0204
8	S8	70	15	15	0.00001221	0.055	0.0398
9	S9	60	20	20	0.00002388	0.04032	0.0475

3.1 coefficient of friction

A measure of the amount of resistance that a surface exert on or substance moving over it, equal to the ratio between the maximum frictional force that the surface exert and the force pushing the object towards the surface. The coefficent of friction under different condition are represented by the graph. analysis

c/s area $= \prod r^2$

volume loss = height loss (microns) / area (mm^2)

wear rate = volume loss / sliding distance (m)

wear resistance = sliding distance / volume loss (mm)

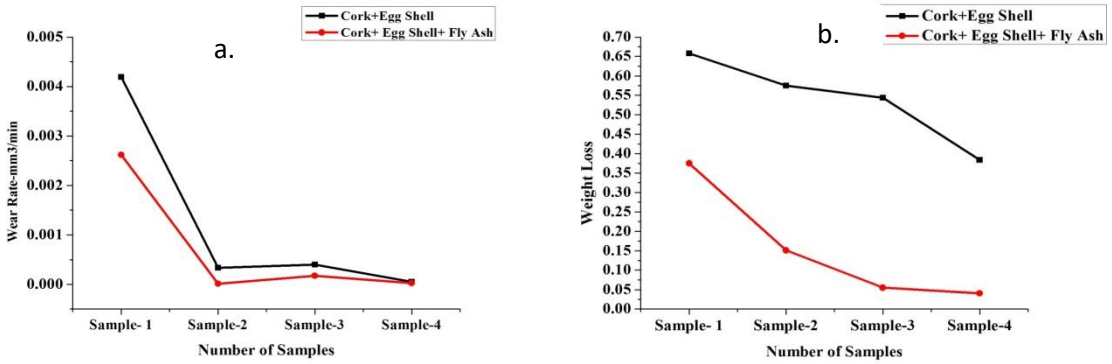

Fig. 4.a.Effect of Wear Rate on Cork+Egg shell composite and Cork+Egg shell+Fly Ash composites
b. Effect of Weight Loss on Cork+Egg shell composite and Cork+Egg shell+Fly Ash composites

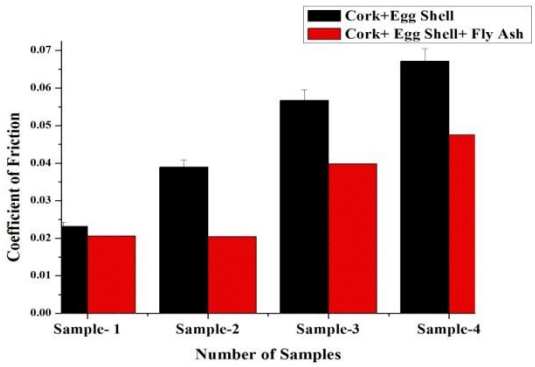

Fig. 5.Effect of Coefficient of friction on Cork+Egg shell composite and Cork+Egg shell+Fly Ash composites

4. Morphological Studies

Worn out specimen after wear analysis are subjected to SEM of FEI quanta 200 FEG (FEI company) at nanotechnology research centre, SRM university. Image of wear tested specimen are taken under the magnification of 10kx.

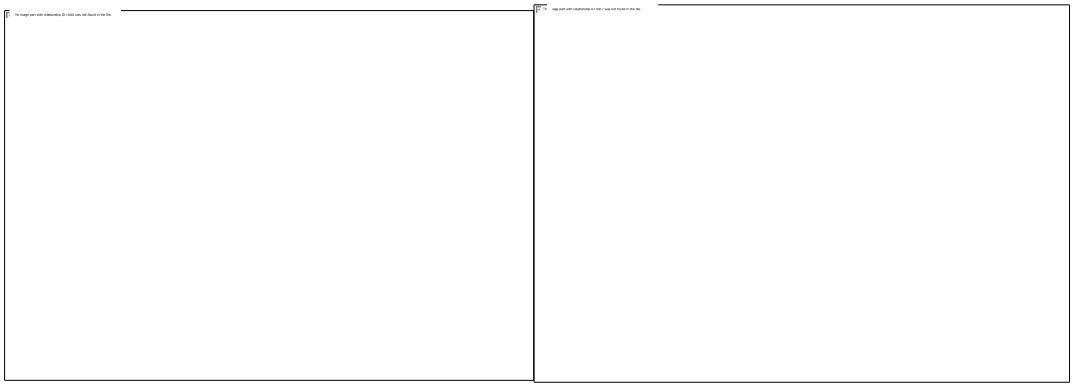

Fig. 6.a. SEM image of Cork b.Cork+Egg shell(70%+30%) composites

c.Cork+Egg shell+Fly Ash(70%+15%+15%) composites

CONCLUSIONS

1. The results revealed that the incorporation of eggshell/fly ash reinforced materials is superior to cork material in comparison of hardness and tribological characteristics (wear rate, coefficient of friction, wear resistence and weight loss).
2. The hardness values raises from 49 BHN to 73 BHN by enhancing cork/eggshell wt% (70:30) then diffusion of flyash particles into Cork/Eggshell/Fly ash composites hardness value enhances to 82 BHN for wt% (70:15:15)
3. The Scanning electron microscopy (SEM) was carried out for worn out samples of cork, Cork/Egg shell and Cork/Eggshell/Fly ash. Micro and transverse fractures, light and extreme wear was observed on the composites.
4. The Cork/Eggshell/Fly ash Natural hybrid composites with wt.% (70:15:15) are very much helpful as better friction lining material.

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